Heteroporella ? *paucicalcarea* (CONRAD, 1970), an Urgonian Dasycladalean alga revisited

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Abstract: When the species *Heteroporella* ? *paucicalcarea* (CONRAD, 1970) was erected it was left in open nomenclature. Later on new combinations were introduced but did not meet a general agreement among paleophycologists. Considering the current acception of the Dasycladalean families, we ascribe it to the Family Polyphysaceae and subsequently to the genus *Clypeina* (MICHELIN, 1845). Its known stratigraphic range is rather brief (Late Hauterivian-Early Barremian), which makes it a good index fossil in Urgonian carbonate platform series. Its geographical distribution is apparently restricted to Western Europe (France, Spain and Switzerland).

Key Words: Calcareous fossil algae; Dasycladales; Polyphysaceae; *Heteroporella*; *Clypeina*; Hauterivian; Lower Barremian.

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Résumé : *Révision de l'* Heteroporella *?* paucicalcarea (*CONRAD, 1970*), une algue dasycladale urgonienne.- À sa création l'espèce *Heteroporella* ? *paucicalcarea* (CONRAD, 1970) a été laissée en nomenclature ouverte. Ultérieurement de nouvelles combinaisons ont été proposées mais aucune n'a rencontrée l'unanimité parmi les paléophycologues. Compte-tenu de l'acception actuelle des familles d'algues dasycladales, nous rapportons ce taxon à la Famille des Polyphysaceae et par contre-coup au genre *Clypeina* (MICHELIN, 1845). Sa répartition stratigraphique connue est plutôt courte (Hauterivien supérieur-Barrémien inférieur), ce qui en fait un bon marqueur fossile dans les séries de plates-formes carbonatées urgoniennes. Sa distribution géographique est apparemment réduite à l'Europe occidentale (Espagne, France et Suisse).

Mots-Clefs : Algues calcaires fossiles ; Dasycladales ; Polyphysaceae ; *Heteroporella* ; *Clypeina* ; Hauterivien ; Barrémien inférieur.

1. Introduction

Further to the 1994 revision of *Heteroporella lepina* PRATURLON, 1967, *i.e.*, the type-species of the genus *Heteroporella* (CROS & LEMOINE *ex* PRATURLON, 1967), the latter was left with one species only (its type, by definition) out of its original sixteen representatives (GRANIER *et al.*, 1994). Most species were ascribed either to *Chinianella* OTT *ex* GRANIER & DELOFFRE, 1993, or to *Otternstella* GRANIER *in* GRANIER *et al.*, 1994; few specific epiteths were considered *nomina nuda* whereas five species were left in open nomenclature, awaiting revision. *Heteroporella* ? *paucicalcarea* CONRAD, 1970, is part of this last set and required our attention.

2. Taxonomical background

From its very beginning (CONRAD, 1970), *Heteroporella* ? *paucicalcarea* was in open nomenclature. The question mark following the generic name was fully justified because it was not obvious whether the illustrated specimens were bearing both fertile (large) and sterile (thin) laterals as stated in the original diagnosis of the genus (PRATURLON, 1967), that is prior to its revision (GRANIER *et al.*, 1994). Actually the pores corresponding to the so-called "sterile hairs, located within and/or between the whorls", which were reported by CONRAD (1970), are merely defined in the interverticillar space by the incompletness of the calcification on the whorls of fertiles laterals.

On the basis of material questionably referred to the species, BUCUR (2000) introduced the new combination, *Similiclypeina paucicalcarea* nov. comb. An option that was sound because the genus *Similiclypeina* BUCUR, 1993, was erected to group *Clypeina*-like species the verticils of which are set rather close together ("les espèces clypeiniformes dont les verticilles sont relativement rapprochés", BUCUR, 1994).

But, in turn, CONRAD *et al.* (2009) introduced another new combination, *Piriferella paucicalcarea* nov. comb., which was fully backed by BUCUR (*in* CONRAD *et al.*, 2009; BUCUR, 2011). There are some side consequences:

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1- for instance, the species *Clypeina somalica* CONRAD *et al.*, 1983, was successively transferred to *Holosporella* PIA, 1930 (GRANIER *et al.*, 1991), then to *Similiclypeina* BUCUR, 1993 (BUCUR, 1993), and finally to *Piriferella* SOKAČ, 1996 (SOKAČ, 1996; CONRAD *et al.*, 2009). CONRAD *et al.* (1983) stated that its thallus bears verticils with noncontiguous branches, even near to the main axis ("Rameaux (...) jamais contigus même à proximité du siphon", *ibid.*); accordingly this species should have been excluded from genera *Clypeina* (MICHELIN, 1845) and *Similiclypeina*. The two remaining genera, *Holosporella* PIA, 1930, and *Piriferella* SOKAČ, 1996, have similar characteristics, the only difference between them being the shape of the laterals. Though the species *somalica* better fits the diagnostic parameters of *Holosporella* (GRANIER *et al.*, 1991; GRANIER & DELOFFRE, 1993), CONRAD *et al.* (2009) favoured the *Piriferella* option. In addition, without giving much consideration to the measurements (particularly the spacing of the verticils and the relative size of the fertile pores), these authors also regarded *Piriferella spinosa* SOKAČ, 1996, the type-species, and *Salpingoporella verrucosa* SOKAČ, 1996, as junior synonyms of *Piriferella somalica* (CONRAD *et al.*, 1983), a statement we should not agree with;

2- the genus *Similiclypeina* BUCUR, 1993, is downsized. Actually it might even be considered as monospecific due to the so far unique morphological trait of the proximal part of the laterals in its type-species, *Similiclypeina conradi* BUCUR, 1993;

3- Rather than clearing up the confusion that was there CONRAD *et al.* (2009) added more. Let us remember that *Holosporella* PIA, 1930, *Piriferella* SOKAČ, 1996, and *Salpingoporella* PIA *in* TRAUTH, 1917, belong to the Family Triploporellaceae (PIA, 1920), *Heteroporella* (CROS & LEMOINE *ex* PRATURLON, 1967) is a representative of the Family Thyrsoporellaceae (GRANIER & BUCUR *in* GRANIER *et al.*, 2012), whereas both *Clypeina* (MICHELIN, 1845) and *Similiclypeina* BUCUR, 1993, are ascribed to the Family Polyphysaceae (KÜTZING, 1841).

In conclusion, except for one small detail, it would be safer to revert to BUCUR's (2000) view: *Heteroporella* ? *paucicalcarea* is a *Clypeina*-like species the verticils of which are set rather close together. Because the species lacks the typical pattern of the laterals in *Similiclypeina conradi* BUCUR, 1993, it should "naturally" be relocated among the representatives of *Clypeina* (MICHELIN, 1845).

3. Description of the new material

Material: The studied material consists of some tens of thin sections, each containing one to several sections (mostly oblique and more or less well preserved) of the alga. Part of the material (Fig. 1), the one from Haute-Savoie (France), is derived from rock samples collected by TRABOLD (1996) during field work to complete a PhD thesis: a first calcareous alga, *Falsolikanella danilovae* (RADOIČIĆ *ex* BARATTOLO, 1978), was already revised based on the same set of thin sections (GRANIER *et al.*, 2000). Additional material (Fig. 2) was collected by the author from a section in Drôme (France), where algal remains transported in debris and grain flows can be dated by the ammonites found in the adjacent marls and limestones (GRANIER *et al.*, nearing completion).

Measurements	CONRAD, 1970	This work (TRABOLD Collection)
L	2.5 mm	> 1.75 mm
D	0.85 - 1.5 mm	0.89 - 1.28 mm
d	0.3 - 0.57 mm	0.32 - 0.47 mm
d/D	30% - 48%	25% - 35%
h1 or h2	0.17 - 0.28 mm (h1)	0.23 - 0.43 mm (h2)
l		0.30 - 0.43 mm
p		0.08 - 0.15 mm
e		0.04 - 0.07 mm
w	9 - 18	8 - 14

Table 1: Biometric data of *Clypeina paucicalcarea* (CONRAD, 1970) *nov. comb.* (L: maximum length; D: external diameter; d: diameter of the stem; h1: interverticillar spacing *sensu stricto*, *i.e.*, from the top surface of one whorl to the bottom surface of the next; h2: interverticillar spacing *sensu lato*, *i.e.*, distance from a reference plane in one whorl to the same plane in the next; l: length of the laterals; p: width of the laterals; e: thickness of the calcareous coating on the laterals; w: number of laterals per verticil).

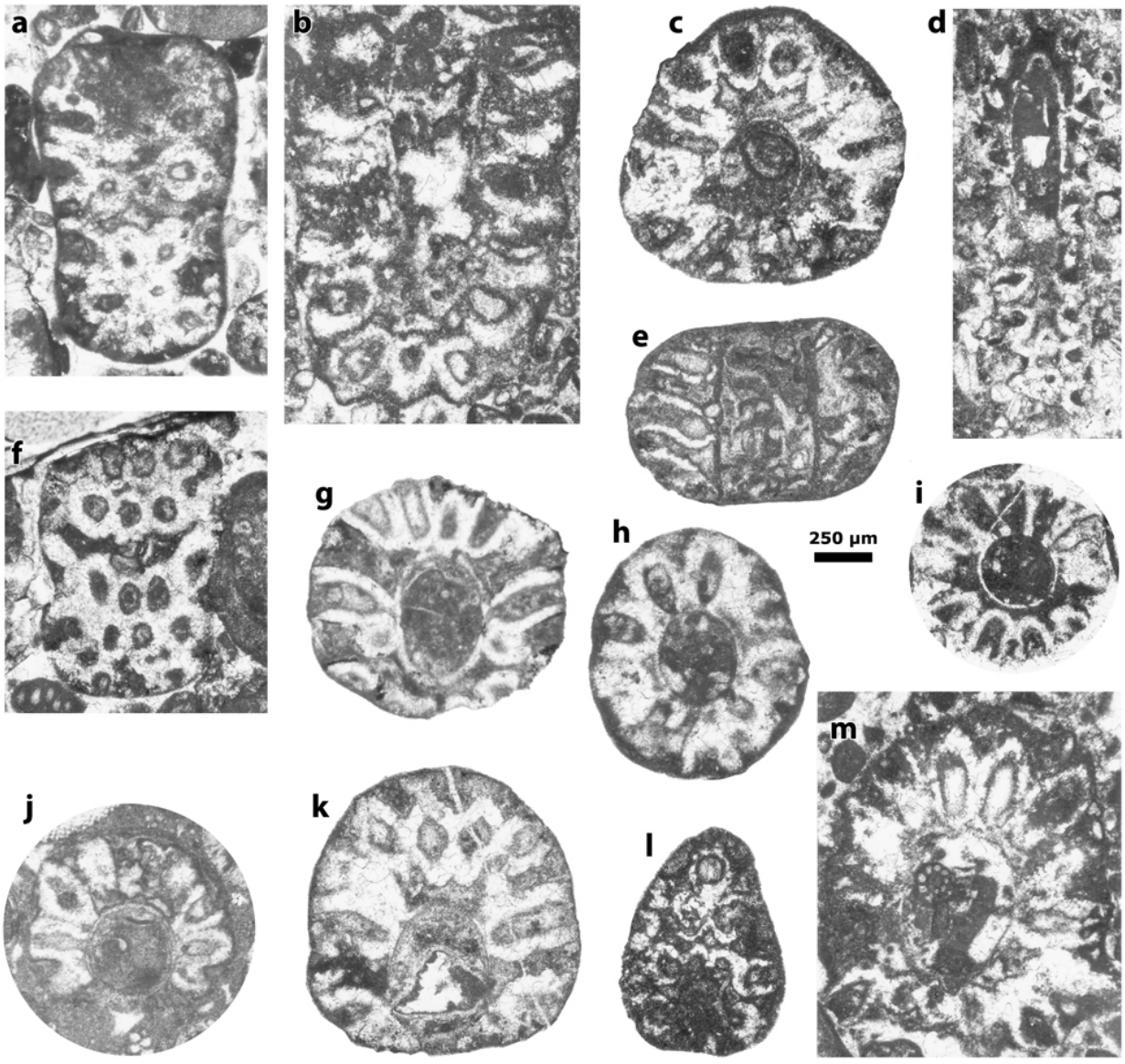

Figure 1: a-c and e-m: *Clypeina paucicalcarea* (CONRAD, 1970) *nov. comb.*

a. oblique to tangential section. GT 1.065 (Upper Hauterivian, Ha6 HST) Rocher de Cluses, Haute-Savoie, France; **b.** oblique to axial section. GT 1.122 (Upper Hauterivian, Ha7 LST) Rocher de Cluses; **c.** oblique to transverse section. FL 2.09 (Lower Barremian, Ba1 LST) Flaine, Haute-Savoie, France; **e.** axial section. GT 1.066 (Upper Hauterivian, Ha6 HST) Rocher de Cluses; **f.** tangential section. GT 1.047 (Upper Hauterivian, Ha6 TST) Rocher de Cluses; **g.** oblique section through 3 verticils. GT 1.067 (Upper Hauterivian, Ha6 HST) Rocher de Cluses; **h.** oblique section. GT 1.098 (Upper Hauterivian, Ha7 LST) Rocher de Cluses; **i.** subtransverse section. BA 19a05 (Upper Hauterivian, Ha6 LST) Combe de Balme, Haute-Savoie, France; **j.** oblique to transverse section. GT 1.101 (Upper Hauterivian, Ha7 LST) Rocher de Cluses; **k.** oblique section through 3 verticils. GT 1.066 (Upper Hauterivian, Ha6 HST) Rocher de Cluses; **l.** oblique section through 4 verticils. FL 2.09 (Lower Barremian, Ba1 LST) Flaine; **m.** oblique section through (?) 2 verticils. GT 1.122 (Upper Hauterivian, Ha7 LST) Rocher de Cluses.

d: oblique to tangential section of a "look-alike" Triploporellacean alga (*Clypeina* is a Polyphysacean alga). Note that laterals are arranged in quinconxes. C5.709 (Upper Hauterivian, Ha7 LST) Plateau d'Andey, Haute-Savoie, France.

All thin sections are stored at the Muséum d'Histoire naturelle, Genève [Scale bar: 250µm]: G. TRABOLD (a-c and e-m) and J. CHAROLLAIS (d) collections [Scale bar: 250µm].

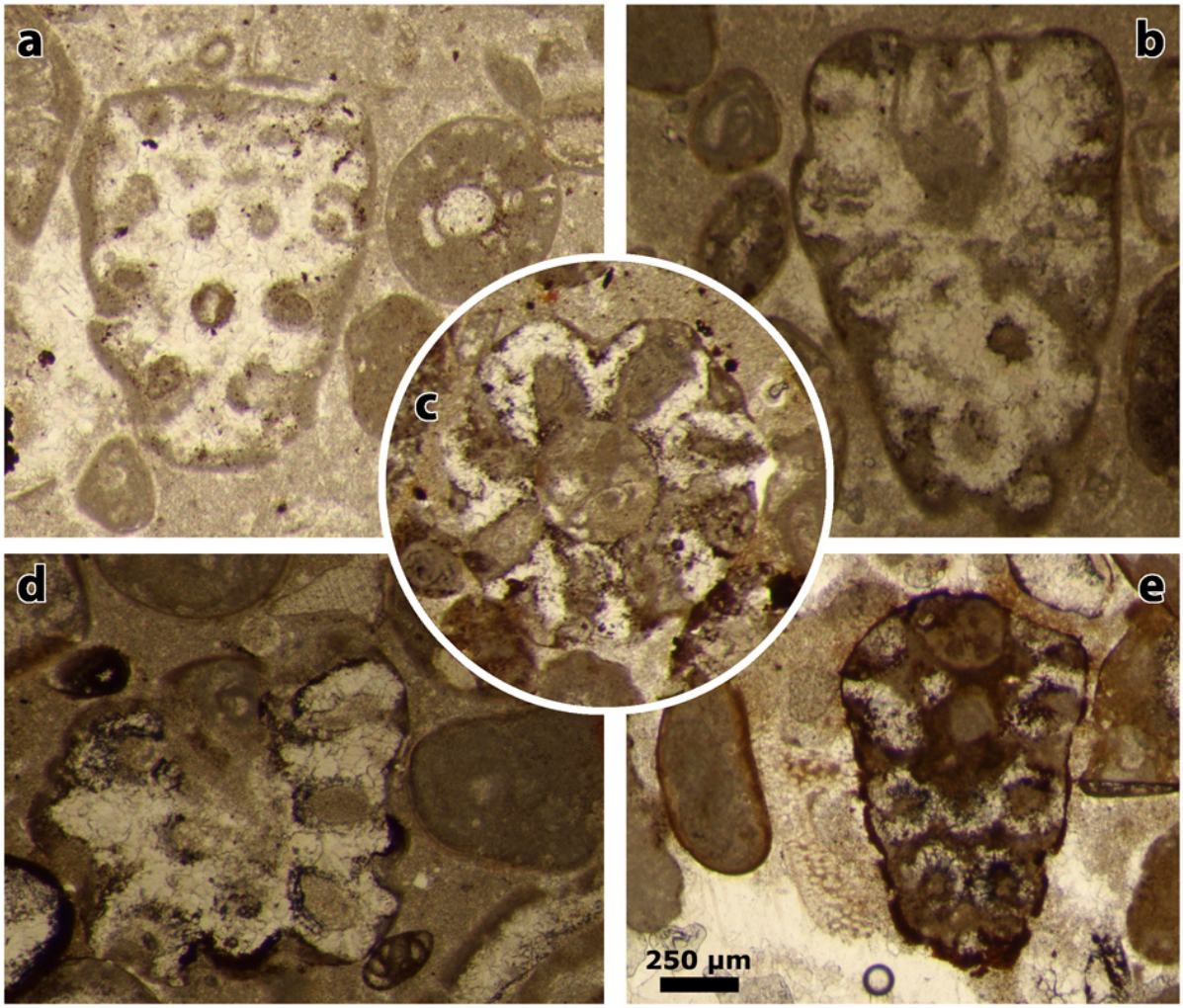

Figure 2: a-e: *Clypeina paucicalcarea* (CONRAD, 1970) *nov. comb.* L'Estellon section, Drôme, France. Ages are directly constrained by ammonites found in strata below and above.

a. tangential section through 4 verticils. EST 26.5 (Nicklesi Zone, Lower Barremian, LST Ba1); **b.** oblique section through 5 verticils. EST 92.3 (Moutonianum Zone, Lower Barremian, LST Ba3); **c.** transverse section of a verticil with 8 primary laterals. EST 49.5 (Pulchella Zone, Lower Barremian, LST Ba2); **d.** oblique section through 3 verticils. EST 92.3 (Moutonianum Zone, Lower Barremian, LST Ba3); **e.** oblique section through 4 verticils. EST 49.7 (Pulchella Zone, Lower Barremian, LST Ba2).

All thin sections from the author's collection [Scale bar: 250µm].

Description: The algal thallus is roughly cylindrical with a cylindrical main axis bearing whorls (euspondyle type) consisting of 8 to 16 (w) laterals. The calcareous skeleton is broken into segments with rarely more than ten verticils. These verticils are close set, but not imbricated. The interverticillar spacing *sensu stricto* (h1), *i.e.*, the distance from the top surface of one whorl to the bottom surface of the next whorl, is always a positive value (see Table 1). The interverticillar spacing *sensu lato* (h2), *i.e.*, the distance from a reference plane in one whorl (insertion points of a verticil, for instance) to the same plane in the next whorl, is more than twice the thickness of a verticil (see Table 1), that is more than twice the diameter of the laterals (p). These laterals are of the first order only, slightly phloiophorous in shape, *i.e.*, increasing in diameter outward, and supposedly fertile because they form quite wide pores. Within a single verticil, they are first gently inclined (probably upward, in the growth direction) with respect to the algal main axis (up to ? 60°), then they rapidly bend outward and are nearly perpendicular in the medial and distal parts of the whorl, which are almost planar. These laterals are close set in the proximal part of the verticil itself and thus embedded in a joint calcareous coating. But, because their diameter does not increase significantly, they rapidly diverge distally and as a result each lateral gets an individual coating. The star pattern of the verticils in transverse sections (Fig. 2.c) reminds us that it is known in *Clypeina* and in *Actinoporella* (GÜMBEL *in* ALTH, 1881). The lack of corona structure above or below the verticil allows us to ascribe the species *paucicalcarea* to the genus *Clypeina*.

4. Systematics

Phylum Chlorophyta
Class Dasycladophyceae
HOEK *et al.*, 1995
Order Dasycladales PASCHER, 1931
Family Polyphysaceae (KÜTZING, 1841)
Genus *Clypeina* (MICHELIN, 1845)
Clypeina paucicalcarea (CONRAD, 1970) *nov. comb.*

(Figs. 1 - 2 - 3)

1970 *Heteroporella* ? *paucicalcarea* n. sp.- CONRAD, p. 68-69, Fig. 5 (holotype, duplicated in Fig. 3 herein), Pl. III, figs. 1-4; Pl. IV, figs. 1-3
1970 *Heteroporella* ? aff. *paucicalcarea* n. sp.- CONRAD, p. 68-69, Pl. IV, fig. 4
1973 *Heteroporella* (?) *paucicalcarea*.- JAFFREZO, p. 80, Pl. 3, figs. 9-11 & 16
1976 *Heteroporella* ? *paucicalcarea*.- PEYBERNÈS, Pl. XXIV, figs. 14-16
1976 *Heteroporella* ? *paucicalcarea*.- CONRAD & PEYBERNÈS, p. 185-186, Figs. 10.a-b & 13a
1976 *Heteroporella* (?) *paucicalcarea*.- MASSE, p. 177, Pl. 4, fig. 7
1978 *Heteroporella* ? *paucicalcarea*.- BASSOULLET *et al.*, p. 133, Pl. 15, figs. 5 (= Fig. 5 in CONRAD, 1970), 6 (= Pl. III, fig. 1 in CONRAD, 1970), 7 (= Fig. 10.a in CONRAD & PEYBERNÈS, 1976) & 8 (= Fig. 10.b in CONRAD & PEYBERNÈS, 1976)
1980 *Heteroporella* ? *paucicalcarea*.- ARNAUD-VANNEAU, Pl. 111, figs. 3–5
1980 *Heteroporella* (?) *paucicalcarea*.- JAFFREZO, p. 252-253, Pl. XIX, figs. 1, 2 (= Pl. 3, fig. 9 in JAFFREZO, 1973), 3 & 4 (= Pl. 3, fig. 11 in JAFFREZO, 1973)
1989 *Heteroporella* ? *paucicalcarea*.- CONRAD & MASSE, p. 281-282, Pl. II, fig. 11
1993 *Heteroporella* ? *paucicalcarea*.- MASSE, Pl. 2, fig. 1 (= Pl. 4, fig. 7 in MASSE, 1976)
1993 *Heteroporella* ? *paucicalcarea*.- GRANIER & DELOFFRE, p. 33
non 1993 *Heteroporella* ? aff. *paucicalcarea*.- BODROGI *et al.*, p. 64, Pl. 3, fig. 3
non 1993 *Heteroporella* (?) *paucicalcarea*.- BUCUR *et al.*, Pl. II, fig. 4
non 1993 *Heteroporella* ? *paucicalcarea*.- SOTÁK & MIŠÍK, Pl. 5, figs. 1-2
1994 *Heteroporella* ? *paucicalcarea*.- GRANIER *et al.*, p. 135
non 1994 *Heteroporella* ? *paucicalcarea*.- BUCUR, p. 152, Pl. VI, fig. 13
non 2000 *Similiclypeina paucicalcarea* nov. comb.- BUCUR, p. 60, Pl. IV, fig. 7
non 2000 *Similiclypeina* aff. *paucicalcarea*.- BUCUR *et al.*, Pl. VIII, figs. 3-4
2007 *Similiclypeina paucicalcarea*.- BUCUR *et al.*, Figs. 4.6 & 4.9
2007 *Salpingoporella genevensis*.- CLAVEL *et al.*, Pl. 6, fig. o
2007 *Piriferella paucicalcarea*.- CLAVEL *et al.*, Pl. 6, fig. p
non 2007 *Piriferella paucicalcarea*.- CLAVEL *et al.*, Pl. 6, fig. q
2009 *Piriferella paucicalcarea* nov. comb.- CONRAD *et al.*, p. 26
2011 *Piriferella paucicalcarea*.- BUCUR, p. 628, Pl. 1, figs. 6-7; Pl. 2, fig. 13; Pl. 6, figs. 5 & 8

Emended diagnosis: *Clypeina* representative with close set verticils consisting of 8 to 16 slightly phloiophorous laterals. Corresponding pores first gently inclined, then rapidly bending outward and almost horizontal distally. Biometric measurements (Table 1) might help discriminating this species from the other representatives of the genus.

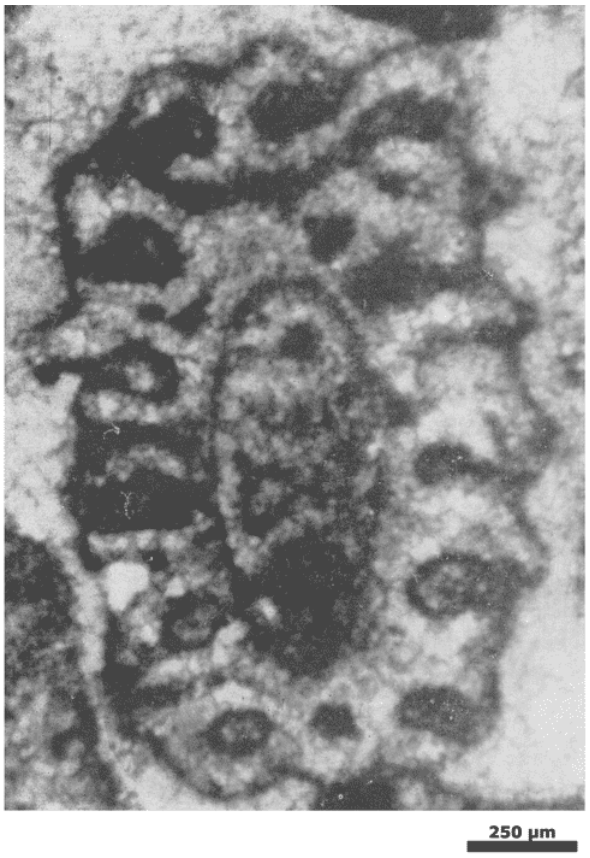

Figure 3: Holotype of *Clypeina paucicalcarea* (CONRAD, 1970) *nov. comb.* Oblique section through 6 verticils. Sample CONRAD 319, slide 6 (Upper Hauterivian, TST Ha5); Rocher-des-Hirondelles, La Rivière, Ain, France; M.A. CONRAD Collection, Muséum d'Histoire naturelle, Genève. Scale bar: 250µm [Some rights reserved].

5. Discussion

Clypeina paucicalcarea (CONRAD, 1970) *nov. comb.* has been reported from strata ranging in age from the Hauterivian to the Bedoulian: (? Upper) Hauterivian (CONRAD & MASSE, 1989), Lower Barremian (CONRAD, 1970; PEYBERNÈS, 1976; CONRAD & PEYBERNÈS, 1976; MASSE, 1976, 1993; ARNAUD-VANNEAU, 1980; BUCUR *et al.*, 2007; CLAVEL *et al.*, 2007), undifferencied Barremian (JAFFREZO, 1980), undifferencied Barremian-Bedoulian (JAFFREZO, 1973). The authors reporting the early finds were not able to discriminate the age of the Urgonian strata they were dealing with. Today the known range can be reduced to the (?) Late Hauterivian - Early Barremian interval. The first occurrence is not accurate because we lack information on Lower Hauterivian (and even Valanginian) shallow-

water carbonates. The last occurrence is better approximated. According to MASSE (1993) the species is not known above the Pulchella Zone (Early Barremian) although according to CLAVEL (personal communication, Dec. 2012) it is still present in the Moutonianum Zone, *i.e.*, in the last ammonite zone of the Early Barremian.

This Urgonian species was found in several localities of W Switzerland (Genève: CONRAD, 1970), S France (Eastern Pyrenees: JAFFREZO, 1973, 1980, PEYBERNÈS, 1976, CONRAD & PEYBERNÈS, 1976; Provence: MASSE, 1976, 1993; Ardèche and Drôme: ARNAUD-VANNEAU, 1980, BUCUR *et al.*, 2007, CLAVEL *et al.*, 2007, BUCUR, 2011), and N Spain (Eastern Pyrenees: CONRAD & PEYBERNÈS, 1976, not illustrated). There it is commonly found associated to the classical "lower" Urgonian species: *Falsolikanella danilovae* (RADOIČIĆ *ex* BARATTOLO, 1978), *Pseudoactinoporella fragilis* CONRAD, 1970, *Salpingoporella genevensis* CONRAD *ex* CONRAD *et al.*, 1973, *S. polygonalis* SOKAČ, 1996, *S. muehlbergii* (LORENZ, 1902), *S. melitae* RADOIČIĆ, 1967, ... Records outside that area, *i.e.*, in Hungary (BODROGI *et al.*, 1993), Romania (BUCUR *et al.*, 1993; BUCUR, 1994, 2000), Slovakia (SOTÁK & MIŠÍK, 1993) and Turkey (BUCUR *et al.*, 2000), are not certified. Therefore the MASSE's (1993) hypothesis regarding a possible algal provincialism in Western Europe remains valid.

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